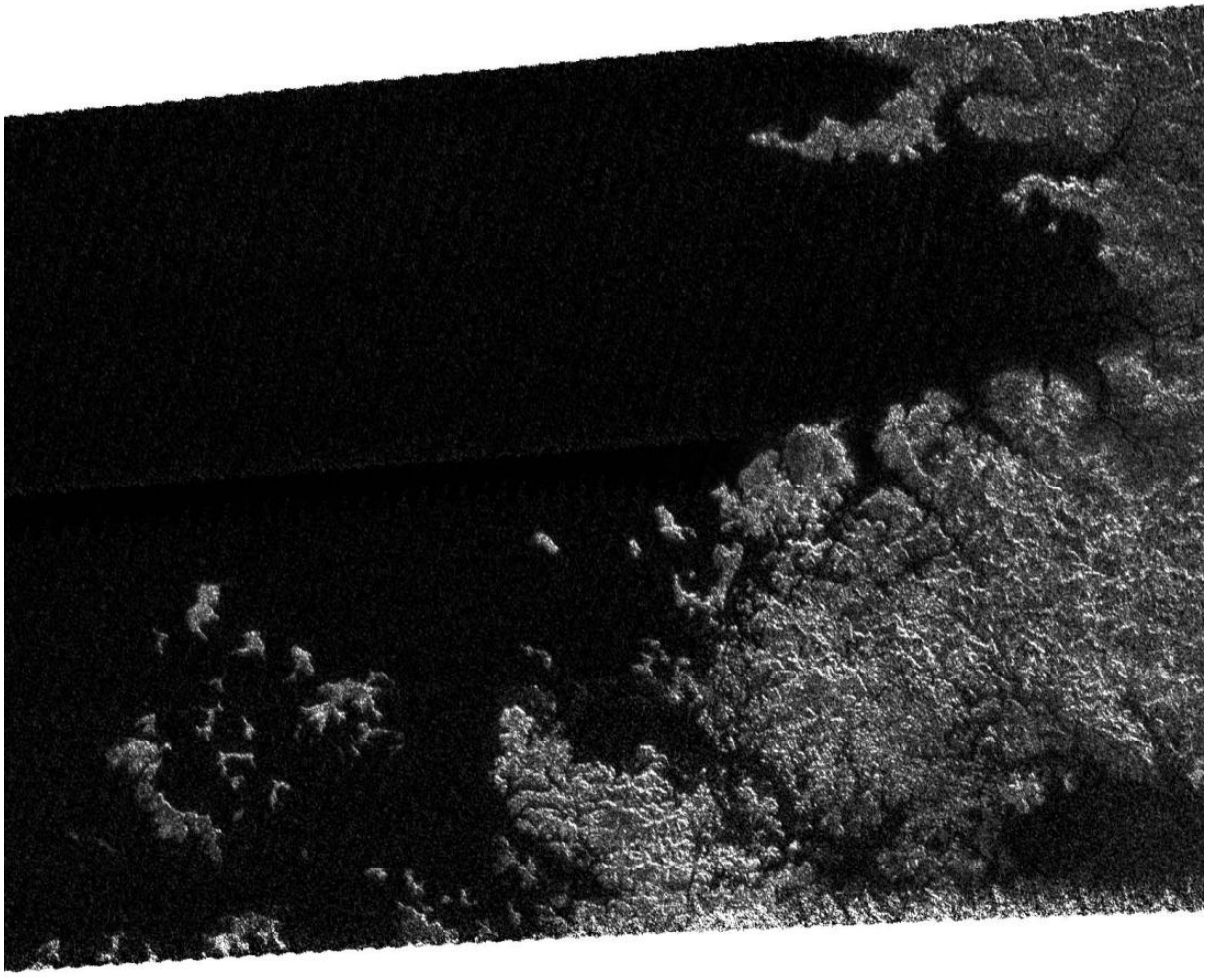
C A S S I N I



T I T A N 046TI(T32)
MISSION DESCRIPTION

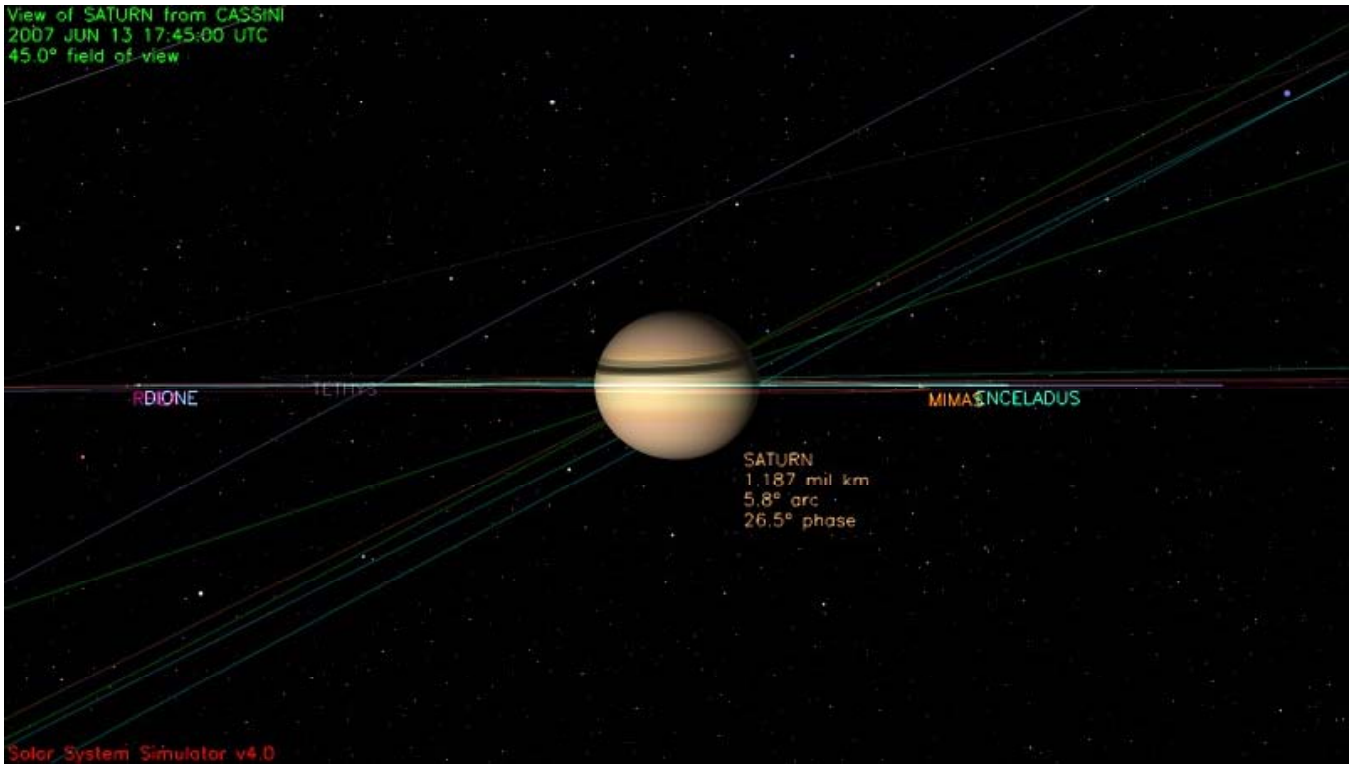
June 2007

Jet Propulsion Laboratory
California Institute of Technology

1.0 OVERVIEW

Sixteen days after Cassini's Titan-31 flyby, the spacecraft returns to Titan for its thirty-third targeted encounter. The closest approach to Titan occurs on Wednesday, June 13, at 2007-164T17:46:11 spacecraft time at an altitude of 975 kilometers (~606 miles) above the surface and at a speed of 6.2 kilometers per second (13,870 mph). The latitude at closest approach is 84.5 degrees N and the encounter occurs on orbit number 46.

This encounter is set up with two maneuvers: an apoapsis maneuver on June 5, and a Titan approach maneuver, scheduled for June 10. This is the eighth in a series of outbound Titan encounters (until T34) , and occurs just under two days after Saturn closest approach



1.1 ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.2 TITAN-32 SCIENCE HIGHLIGHTS

- INMS: T32 will be the highest latitude Titan pass on which INMS will be in the driver's seat as the prime instrument. It is the only pass that occurs close to midnight local time, on the ram side of Titan, while Titan is on the Sun lit side of Saturn. This is a magnificent opportunity for in situ science of Titan's atmosphere in this unique geometry.
- ISS conducts high-resolution (104-240 m/pixel) imaging & global-scale mapping of the bright-dark boundary. There will also be a full-disk, color mosaic (centered at 1.7 N, 219 W) at 1.4-1.6 km/pixel resolution.
- VIMS carries out high-resolution mapping of Titan's north pole. Observations include global mapping and monitoring for temporal changes. VIMS will also carry out a hot spot and lightning search.
- CIRS will continue to search for new species in the far-IR, in the far north. CIRS will also map temperatures in the upper troposphere across the north polar region, and in the stratosphere around approximately 1/4 of the disk. CIRS also gains the chance to map the distribution of aerosols on the limb in detail.
- UVIS will observe a solar ingress occultation. The observation samples mid-southern latitudes (near 50 degrees south). Solar occultations are observed with the UVIS EUV channel which measures H, H2, N, N2 and some hydrocarbons from the exobase (the altitude where molecules or atoms can escape to space just from their thermal velocity because there are not enough atoms or molecules above them to stop them by collisions, near 3000 Km to about 600 Km altitude).

1.3 SAMPLE SNAPSHOTS

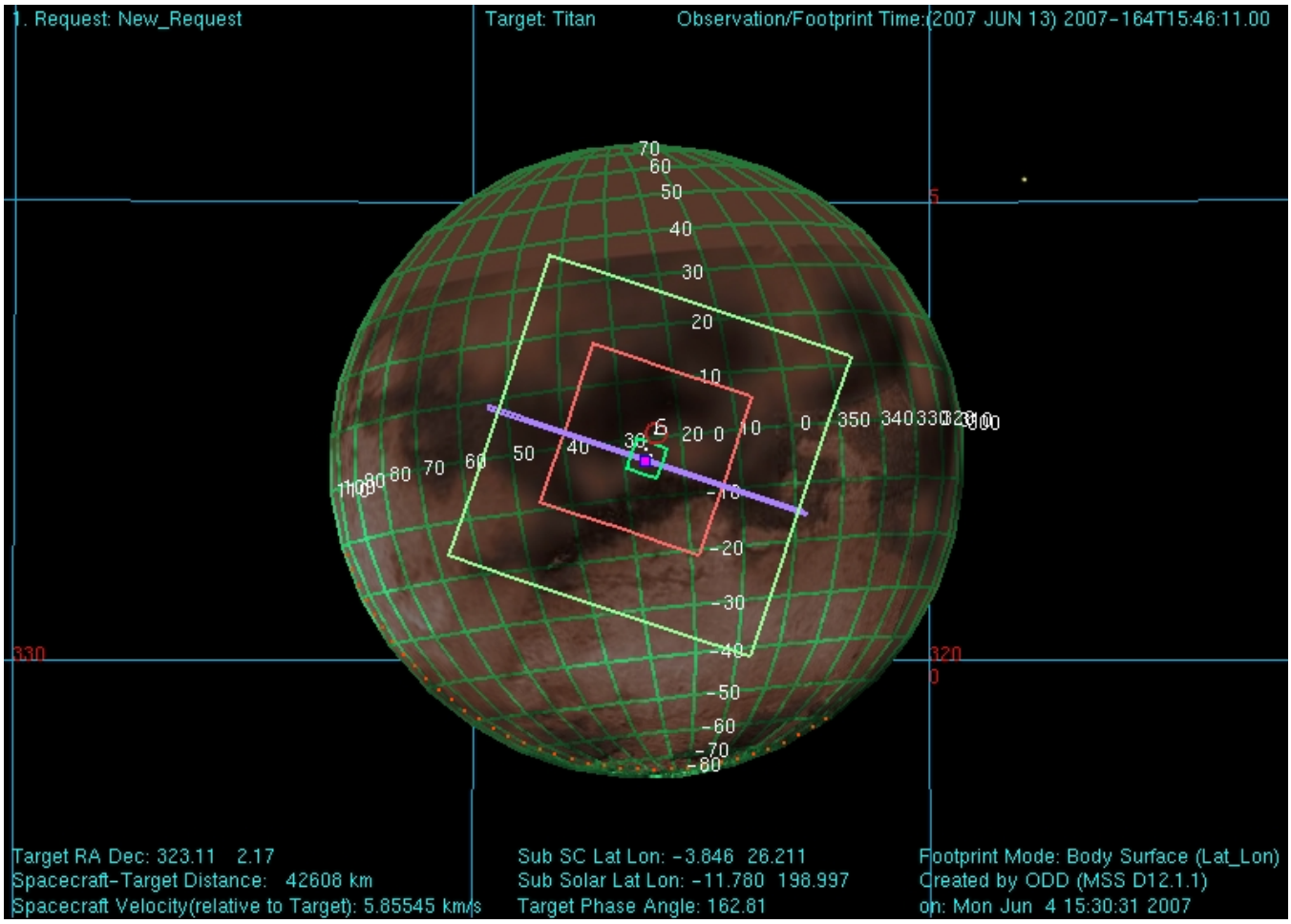
Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments' fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields

of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

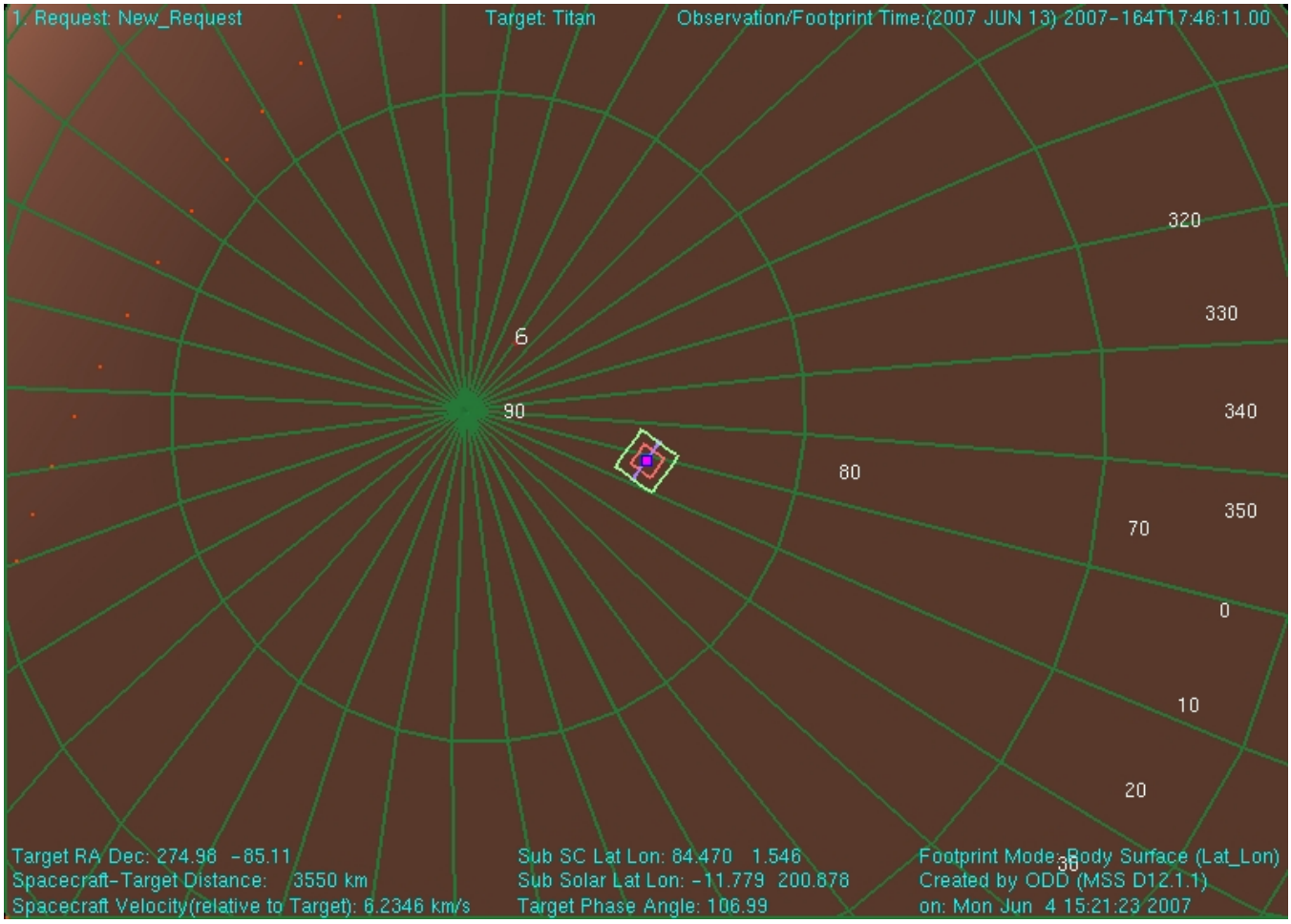
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

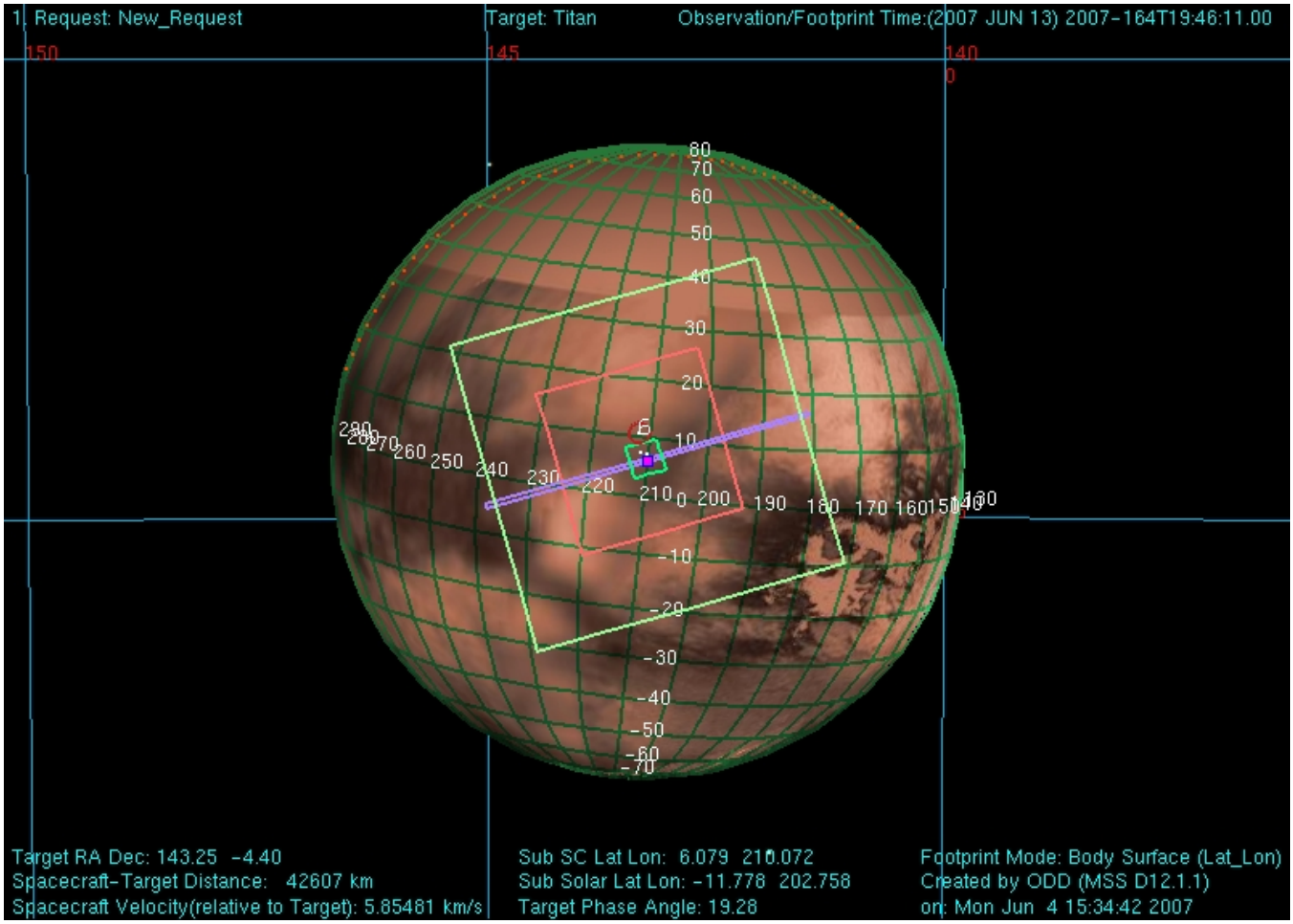
View of Titan from Cassini two hours before Titan-32 closest approach



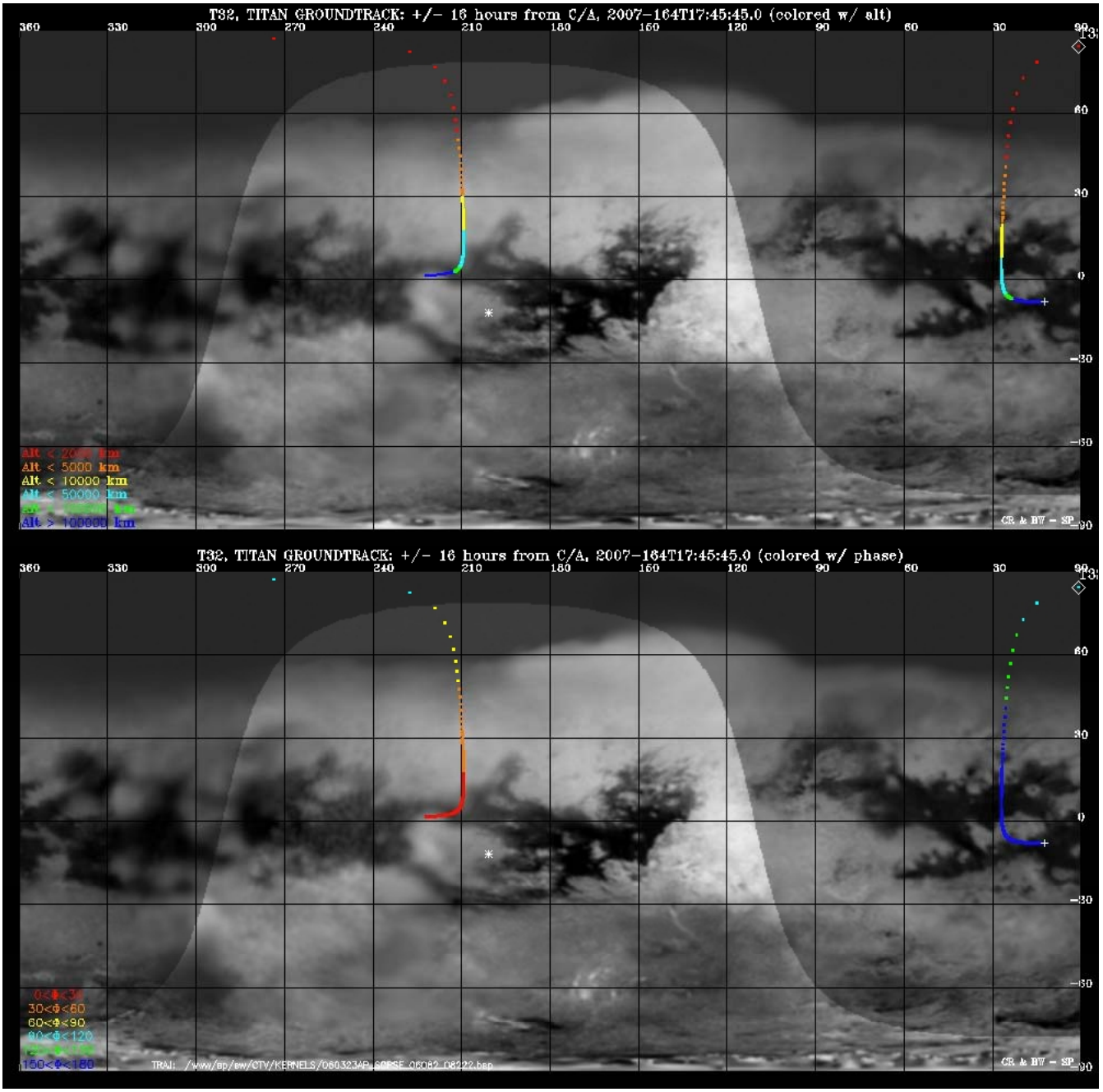
View of Titan from Cassini at Titan-32 closest approach



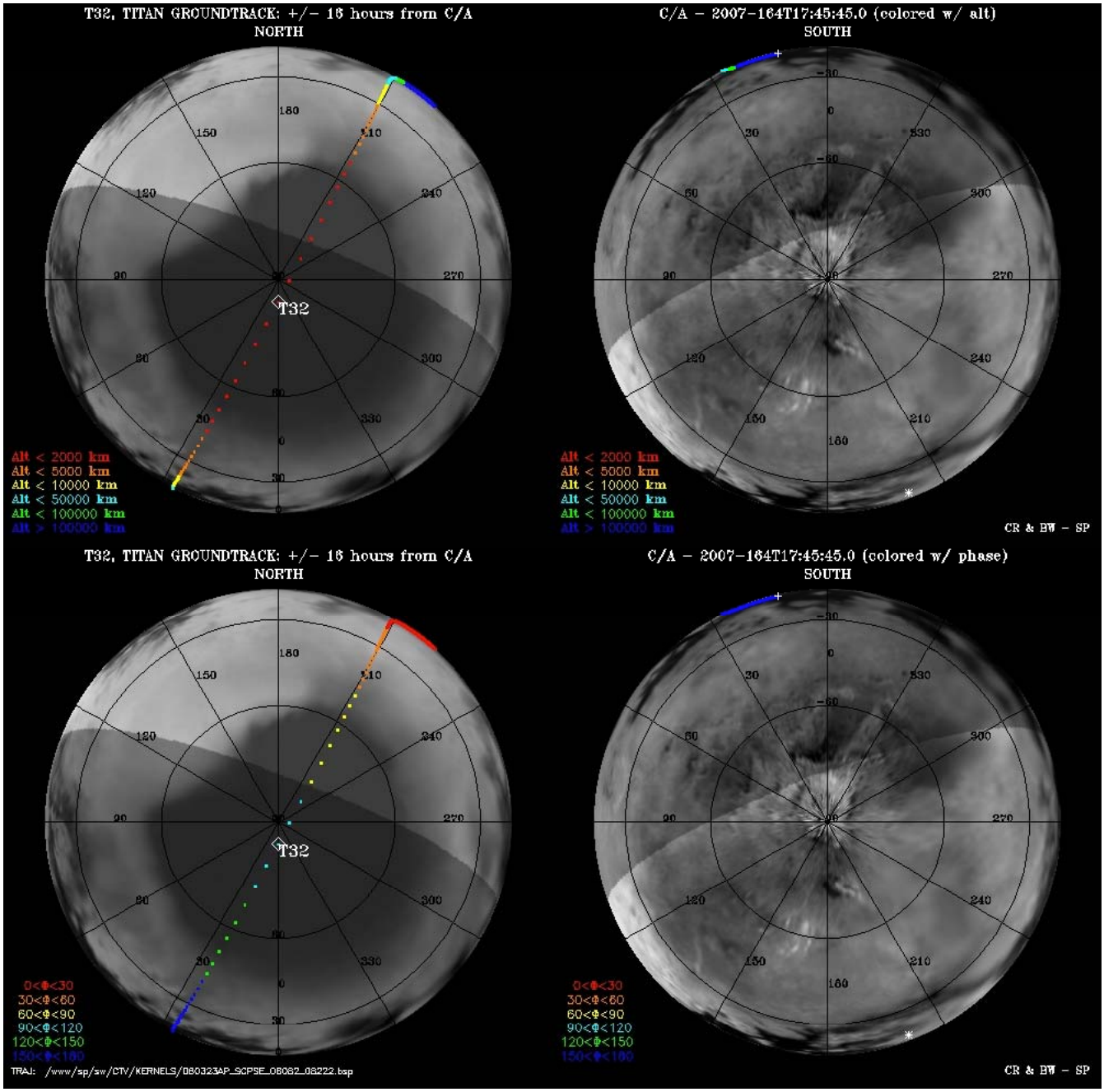
View of Titan from Cassini two hours after Titan-32 closest approach



Titan Groundtracks for T32: Global Plot



Titan Groundtracks for T32: Polar Plot



The T32 timeline is as follows:

Cassini Titan-32 Timeline - June 2007

Colors: yellow = maneuvers; blue = geometry; pink = T29-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T32	Activity	Description
162T03:10:00	Jun 11 04:31	Sun Jun 10 08:31 PM	T32-02d15h	Start of Sequence S31	Start of Sequence which contains Titan-32
161T18:10:00	Jun 10 19:31	Sun Jun 10 11:31 AM	T32-02d24h	OTM #115 Prime	Titan-32 targeting maneuver.
162T09:10:00	Jun 11 10:31	Mon Jun 11 02:31 AM	T32-02d09h	OTM #115 Backup	
162T23:30:13	Jun 12 00:51	Mon Jun 11 04:51 PM	T32-01d18h	Descending Ring Plane Crossing	
163T00:45:24	Jun 12 02:06	Mon Jun 11 06:06 PM	T32-01d17h	Saturn Periapse	Saturn periapse, R = 2.7 Rs, lat = -9 deg, phase = 123 deg
164T02:54:00	Jun 13 04:15	Tue Jun 12 08:15 PM	T32-14h52m	Start of the TOST segment	
164T02:54:00	Jun 13 04:15	Tue Jun 12 08:15 PM	T32-14h52m	Turn cameras to Titan	
164T03:24:00	Jun 13 04:45	Tue Jun 12 08:45 PM	T32-14h22m	Deadtime	15 minutes 11 seconds long; used to accommodate changes in flyby time
164T03:39:11	Jun 13 05:00	Tue Jun 12 09:00 PM	T32-14h07m	Titan atmospheric Observations	Obtain information on the thermal structure of Titan's stratosphere. Obtain information on CO, HCN, CH4.
164T04:46:11	Jun 13 06:07	Tue Jun 12 10:07 PM	T32-13h00m	Titan atmospheric Observations	Cloud map
164T08:46:11	Jun 13 10:07	Wed Jun 13 02:07 AM	T32-09h00m	Titan atmospheric Observations	Obtain vertical profiles of temperatures in Titan's stratosphere.
164T12:46:11	Jun 13 14:07	Wed Jun 13 06:07 AM	T32-05h00m	Titan surface observations	Scans across visible hemisphere to form spectrall images
164T14:46:11	Jun 13 16:07	Wed Jun 13 08:07 AM	T32-03h00m	ISS Imaging	Search for and monitor lightning and aurora
164T15:46:11	Jun 13 17:07	Wed Jun 13 09:07 AM	T32-02h00m	New Waypoint	
164T16:12:11	Jun 13 17:33	Wed Jun 13 09:33 AM	T32-01h34m	Solar Occultation observation	Measure transmission of EUV solar radiation through the Titan atmosphere. Obtain atmospheric vertical temperature distribution, composition. Identify haze layers.
164T16:39:11	Jun 13 18:00	Wed Jun 13 10:00 AM	T32-01h07m	Operating mode transition	
164T17:01:37	Jun 13 18:22	Wed Jun 13 10:22 AM	T32-00h45m	Earth Occultation	40 minute duration
164T17:02:09	Jun 13 18:23	Wed Jun 13 10:23 AM	T32-00h44m	Solar Occultation	39 minute duration
164T17:03:35	Jun 13 18:24	Wed Jun 13 10:24 AM	T32-00h43m	Titan nightside imaging	High resolution nightside imaging
164T17:24:11	Jun 13 18:45	Wed Jun 13 10:45 AM	T32-00h22m	Magnetosphere and TOST Campaign	Determine atmospheric and ionospheric composition and thermal structure.
164T17:42:19	Jun 13 19:03	Wed Jun 13 11:03 AM	T32-00h04m	Ascending Ring Plane Crossing	Determine atmospheric and ionospheric composition and thermal structure.
164T17:46:11	**Jun 13 19:07**	**Wed Jun 13 11:07 AM**	T32+00h00m	**Titan-32 Flyby Closest Approach Time**	**Altitude = 975 km (605 miles), speed = 6.2 km/s (13,870 mph); 107 deg phase at closest approach**
164T18:01:11	Jun 13 19:22	Wed Jun 13 11:22 AM	T32+00h15m	Turn to limb	
164T18:08:11	Jun 13 19:29	Wed Jun 13 11:29 AM	T32+00h22m	Operating mode transition	
164T18:32:11	Jun 13 19:53	Wed Jun 13 11:53 AM	T32+00h46m	Titan atmospheric Observations	Vertical temperature sounding of Titan's tropopause & stratosphere.
164T18:48:11	Jun 13 20:09	Wed Jun 13 12:09 PM	T32+01h02m	Titan surface observations	High resolution regional mapping.
164T19:46:11	Jun 13 21:07	Wed Jun 13 01:07 PM	T32+02h00m	New Waypoint	
164T20:04:11	Jun 13 21:25	Wed Jun 13 01:25 PM	T32+02h18m	Titan atmospheric Observations	Obtain information on surface & tropopause temperatures, and on tropospheric CH4.
164T22:46:11	Jun 14 00:07	Wed Jun 13 04:07 PM	T32+05h00m	Titan atmospheric Observations	Medium resolution global mapping.
165T00:46:11	Jun 14 02:07	Wed Jun 13 06:07 PM	T32+07h00m	ISS Imaging	Global map
165T02:46:11	Jun 14 04:07	Wed Jun 13 08:07 PM	T32+09h00m	Titan atmospheric Observations	Obtain information on CO, HCN, CH4.
165T04:46:11	Jun 14 06:07	Wed Jun 13 10:07 PM	T32+11h00m	ISS Imaging	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes
165T06:46:11	Jun 14 08:07	Thu Jun 14 12:07 AM	T32+13h00m	Titan surface observations	Regional map
165T07:46:11	Jun 14 09:07	Thu Jun 14 01:07 AM	T32+14h00m	Titan atmospheric Observations	Obtain information on the thermal structure of Titan's stratosphere.
165T10:01:11	Jun 14 11:22	Thu Jun 14 03:22 AM	T32+16h15m	Deadtime	15 minutes 7 seconds long; used to accommodate changes in flyby time
165T10:17:00	Jun 14 11:38	Thu Jun 14 03:38 AM	T32+16h31m	Turn to Earth-line	
165T10:47:00	Jun 14 12:08	Thu Jun 14 04:08 AM	T32+17h01m	Playback of T32 Data	Madrid 70M and 34M